## Specifications for Large Tracking System (LTS):

The large tracking system consists of a pedestal and an enclosure for that pedestal, mounted on a mobile trailer. Specifications are listed for each part of the tracking system.

- Pedestal
- Trailer
- Pedestal enclosure
- Control System
- Documentation / Training

Each category of specifications is broken into *required* and *highly-desired*, based on input from several Ranges within the Optical Systems Group.

### Pedestal:

Required specifications:

1. 1200+ lbs. payload

2. 6 mounting platforms
    a. One on each side outboard of the elevation axis bearing assemblies, 48" in length and 26" wide
    b. One in between the elevation axis bearing assemblies
    c. Each with over and under mounting access
    d. Each of the six platforms bearing weight 200 lbs
    e. Width of center platform wide enough to accommodate at least a 24-inch diameter lens
    f. Standard T-bolt mounting slots

3. Digital control system, preferably PC104 architecture
    a. position-loop architecture to handle non-linear amplifier/load combination, i.e. current saturation
    b. diagnostics
    c. remote control and monitoring of safety functions
    d. automatic characterization and notch (for payload changes)
    e. programmable filters
    f. storable configurations with easy retrieval

4. At least 21-bit encoders, inductosyn or optical

5. Acceleration - Continuously variable from 0 to at least 45 deg/sec$^2$

6. Velocity - Continuously variable from 0.6 to at least 45 deg/sec

7. Modular cabling interfaces for improved troubleshooting and technological adaptation on tines
    a. 1– 10 video lines with isolated feed-through
    b. 6 Ethernet (shielded CAT-6 and covered RJ-45 receptacles)
    c. 4 – 6 fiber optics pairs (single-mode)
    d. 1– 2 VSR-192 cables (12 fibers each)
    e. 4 – 6 RS232/422 cables
    f. FDA cabling

g. 2-4 trigger lines
h. 2– 4 IRIG lines
i. Digital cameral controls

8. Transient Response
    a. When a 0.5 volt step input is applied to the drive input, the tachometer output shall not overshoot the final velocity by more that 5% and shall be damped to 2% within 1 cycle.

9. Three-point leveling and shock absorber system
    a. Stationary base assembly of the pedestal interfacing with the trailer base structure
    b. Leveling screws – 6 minute, circular (bulls eye) installed for viewing when performing pedestal leveling procedures

10. Master bubble level with range of 10 arc seconds and resolution of +/- 2 arc seconds

11. Azimuth carriage assembly
    a. two cavities that will provide space for camera control or other electronics
    b. rotation of 335 degrees in each direction from the center point, for a total of 670 degrees
    c. analog dc voltage output proportional to the rotation of the azimuth axis

12. Elevation tracking assembly
    a. Transport locks at 0, 90 and 180 degrees
    b. Rotation of 210 degrees
    c. analog dc voltage output proportional to the rotation of the elevation axis
    d. Perpendicular to azimuth axis, with full weight load, throughout entire range of travel to within +/- 5 arc seconds

13. Side mounting structure shall allow for +/- 4 inches of vertical movement

14. Ability to remotely drive pedestal out of the limit

15. Electronic pre-limits to prevent driving axis into the hard stop

16. Transport locks shall be electrically interlocked with the servo system

Highly-desired specifications:

1. Weatherproof
    a. operable in all weather conditions
    b. temperature and humidity controlled electronic bays

2. Velocity - Dynamic range of 1000 to 1 (i.e. at 15 deg/sec average velocity, the actual velocity deviation must not exceed +/-0.015 deg/sec)

3. Energized servo system random drift shall not exceed 1 degree over a 3 minute interval of time, where the source of the drift includes all internal system fluctuations due to temperature, vibration and aging of the component parts.

4. Acceleration - Continuously variable from 0 to 120 deg/ $sec^2$

5. Velocity - Continuously variable from 0.6 to 120 deg/sec

6. Stainless steel hardware

7. Rate loop frequency response bandwidth at least 6 Hz

8. Encoder Strobe
    a. Low TTL pulse
    b. Data available for reading within 600ns of falling edge
    c. Data latched until rising edge

9. Bearing System Accuracy
    a. Bearing runout no greater than +/- 3 arc seconds
    b. Azimuth and elevation wobble no greater than +/- 2 arc seconds

10. Azimuth sliprings

11. Center mounting structure
    a. Adjustable through +/- 2 degrees of arc
    b. Indexing reference to allow package to be removed and reinstalled to within +/- 0.125 degrees of original position

12. Dynamic and static accuracy
    a. The encoder system shall provide mount position to an accuracy of +/- 0.00137 deg during tracking ( about 5 arc seconds).

**Trailer**

Required specifications:

1. Working deck for the user and housing for the electronics
    a. 12 – 15 feet length
    b. 6.5 – 7 ft wide
    c. 33 – 36 inches off the ground
    d. Expanding sides for additional 15 inches of work surface on each side
    e. Gross weight of pedestal, electronics and enclosure not to exceed 10,000 lbs

2. Air-conditioner and humidity controls in the trailer for the electronics

3. Transportability
    a. good axels, tires and shock absorption
    b. air-ride suspension
    c. 4 tire axles

4. Brakes
    a. Service brakes on all wheels
    b. Air brakes on each wheel, controlled from and operated simultaneously with the brakes of the towing vehicle

5. Power and Distribution Panel (PDU)
    a. Combination power ON/OFF switch and circuit breaker
    b. Separate circuit breakers for each side of the azimuth carriage assembly
    c. Common, high-quality ground for both tines and electronics enclosure
    d. Self-cleaning ground connection at trailer i/o panel
    e. Power cable reel
        i. accessible for maintenance
        ii. built-in, ratchet-stop, automatic return
        iii. 50 ft or more of 5 conductor No. 8 AWG with ground, vermin resistant, neoprene type insulation, copper electrical power cable
        iv. Male connector, 60 amp, 240 volt dc, 400 volt ac, Russell Stoll 3128W, 4-pin + GND on power cable end
    f. Reset able/ replaceable surge suppressor with clearly visible diagnostic indicators
    g. Voltage and current meters visible day and night for each phase of the applied 208V, three-phase, 4 conductor, 60 Hz ac power.
    h. Nothing phase-sensitive
    i. Four (4) standard 120V ac, 60 Hz, single phase, three-wire female, GFI-protected convenience receptacles
    j. Some/all convenience receptacles tied to user-provide UPS
    k. Filtered (UPS) and non-filtered busses
    l. Servo chassis input filtered to minimize noise
    m. Motor cabling heavily shielded to minimize switching noise transmission

6. Modular cabling interfaces for improved troubleshooting and technological adaptation for trailer I/O
    a. 2-6 fibers for mount control
    b. 9-port video
    c. 2-4 fiber pairs for digital video and/or digital timing distribution
    d. 4-6 general purpose fiber optic pairs

    e. 1-2 VSR-192 cables ( 50 to 100% spares)

7. Ruggedized cable interfaces

8. Metal jack stands

9. Towing hitch – standard military type pintle compatible with Holland RCXE 1230

10. Safety features
    a. Power kill switch on operator's console and front and back of trailer
    b. Non-skid surface on trailer deck

Highly-desired specifications:

1. Safety features
    a. Deck surface paint for danger areas
    b. Warning light / indicator for live servo
    c. Trailer stairs wide enough for someone carrying equipment
    d. Trailer stairs on both sides of tongue as well as rear

2. Lifting rings at each corner of the trailer, designed for lifting trailer and pedestal with full payload

3. Rotation meters visible day and night

4. auto leveling of trailer
    a. very low speeds necessary to achieve required accuracy
    b. variable speeds necessary to make system usable

5. Spare tire and wheel assembly

6. Shock absorber for the hitch assembly

**Pedestal Enclosure**

Highly-desired specifications:

1. remotely-controlled open/close

2. one person operation with power

3. two person operation without power

4. safety straps to prevent inadvertent side opening

## Control System

Required specifications:

1. Remote stick control
2. Slave to acquisition source
3. TV tracking

Highly-desired specifications:

1. Star calibration capability
2. Auto unwrap
3. Digital system source code
4. Real-time sun avoidance
5. Multi-target tracking

## Documentation / Training

1. Documentation
    a. Hardcopy and electronic
    b. Detailed theory of operation
    c. Maintenance instructions for motor, bearing, encoder
    d. major component removal and replacement instructions
    e. verification of encoder accuracy, orthogonality, bearing wobble and run out
    f. electrical drawings and schematics
    g. parts list
    h.
2. On-site operational and maintenance training
3. Optional factory training

## Specifications for Small Tracking System (STS):

The small tracking system consists only of a pedestal and the system to control it. Each category of specifications is broken into *required* and *highly-desired*, based on input from several Ranges within the Optical Systems Group.

### Pedestal:

Required specifications:

1. 250 lbs. payload

2. 2 to 4 mounting platforms
    a. One on each side outboard of the elevation axis bearing assemblies
    b. Each with over and under mounting access

3. Digital control system, preferably PC104 architecture
    a. position-loop architecture to handle non-linear amplifier/load combination, i.e. current saturation
    b. diagnostics
    c. remote control and monitoring of safety functions
    d. automatic characterization and notch (for payload changes)
    e. programmable filters
    f. storable configurations with easy retrieval

4. At least 21-bit encoders, inductosyn or optical

5. Acceleration - Continuously variable from 0 to at least 120 deg/sec$^2$

6. Velocity - Continuously variable from 0.6 to at least 120 deg/sec

7. Modular cabling interfaces for improved troubleshooting and technological adaptation on tines
    a. 1– 10 video lines with isolated feed-through
    b. 6 Ethernet (shielded CAT-6 and covered RJ-45 receptacles)
    c. 4 – 6 fiber optics pairs (single-mode)
    d. 1– 2 VSR-192 cables (12 fibers each)
    e. 4 – 6 RS232/422 cables
    f. FDA cabling
    g. 2-4 trigger lines
    h. 2– 4 IRIG lines
    i. Digital cameral controls

8. Transient Response
    a. When a 0.5 volt step input is applied to the drive input, the tach output shall not overshoot the final velocity by more that 5% and shall be damped to 2% within 1 cycle.

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a. Leveling screws – 6 minute, circular (bulls eye) installed for viewing when performing pedestal leveling procedures

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    c. analog dc voltage output proportional to the rotation of the azimuth axis

12. Elevation tracking assembly
    a. Transport locks at 0, 90 and 180 degrees
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    d. Perpendicular to azimuth axis, with full weight load, throughout entire range of travel to within +/- 5 arc seconds

13. Side mounting structure shall allow for +/- 4 inches of vertical movement

14. Ability to remotely drive pedestal out of the limit

15. Electronic pre-limits to prevent driving axis into the hard stop

16. Transport locks shall be electrically interlocked with the servo system

Highly-desired specifications:

1. Weatherproof
    a. operable in all weather conditions
    b. temperature and humidity controlled electronic bays

2. Velocity - Dynamic range of 1000 to 1 (i.e. at 15 deg/sec average velocity, the actual velocity deviation must not exceed +/-0.015 deg/sec)

3. Energized servo system random drift shall not exceed 1 degree over a 3 minute interval of time, where the source of the drift includes all internal system fluctuations due to temperature, vibration and aging of the component parts.

4. Stainless steel hardware

5. Rate loop frequency response bandwidth at least 14 Hz

6. Encoder Strobe
    a. Low TTL pulse
    b. Data available for reading within 600ns of falling edge
    c. Data latched until rising edge

7. Bearing System Accuracy
    a. Bearing runout no greater than +/- 3 arc seconds
    b. Azimuth and elevation wobble no greater than +/- 2 arc seconds

8. Azimuth sliprings

9. Center mounting structure
    a. Adjustable through +/- 2 degrees of arc
    b. Indexing reference to allow package to be removed and reinstalled to within +/- 0.125 degrees of original position

10. Dynamic and static accuracy
    a. The encoder system shall provide mount position to an accuracy of +/- 0.00137 deg during tracking ( about 5 arc seconds).

## Control System

Required specifications:

1. Remote stick control
2. Slave to acquisition source
3. TV tracking

Highly-desired specifications:

1. Star calibration capability
2. Auto unwrap
3. Digital system source code
4. Real-time sun avoidance
5. Multi-target tracking

## Documentation / Training

1. Documentation
    a. Hardcopy and electronic
    b. Detailed theory of operation
    c. Maintenance instructions for motor, bearing, encoder
    d. major component removal and replacement instructions
    e. verification of encoder accuracy, orthogonality, bearing wobble and run out
    f. electrical drawings and schematics
    g. parts list
    h.
2. On-site operational and maintenance training
3. Optional factory training